BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

Title

Hydroplaning Hydrofoil/Airfoil Structures and Amphibious and Aquatic Craft

Field of Invention:

This invention relates to hydroplaning hydrofoils, airfoil structures or flying wing structures, light-weight amphibious structures and aquatic crafts and more particularly to hydroplaning hydrofoil/airfoil structures that plane on or through a fluid preferably either water or air which are optionally self-supporting or attached to aquatic structures or watercraft, particularly sailing craft.

Background:

Man continues to dream of going faster and faster. On water and through air, this is evidenced by the changing designs of fresh water and ocean racing watercraft and the stealth aircraft flying wings. Whatever the design, there is a continuing search for new hydrofoils, and airfoil or flying wing structures which will achieve faster speeds on water and through air. U.S. Patent 4,635,577, granted to Palmquist on January 13, 1987, is an example of one attempt to provide a hydroplaning hydrofoil and air wing supported sailing craft.

Summary of the Invention

According to the present invention there is provided a hydroplaning hydrofoil and airfoil structure for planing on or through a fluid preferably either water or air comprising in its broadest aspects for water as exemplified in Figures 21-23: at least two foils each having an underside plane or substantially planar-bottom surface, two of said planar-bottom surfaces intersecting along a fore and aft longitudinal

accelerates through to achieve either hydroplane or airfoil support.

However, variations may be readily apparent to those skilled in the art without detracting from the realities of the structures and performances described in this invention. For example the hydroplaning hydrofoil/airfoil structure in its preferred and most preferred configurations offers additional performance options that include planing on or through a fluid such as water or air. Of course in an airfoil configuration such as an ultralight wing aircraft, glider wing or kite, the same shape hydroplaning hydrofoil/airfoil structure performs as an airfoil wing structure or planar wing structure planing or flying through air herein described.

As will be evidenced from the title of this invention, a hydroplaning hydrofoil/airfoil structure for planing on or flying through a fluid is shown supporting itself in Figures 37 to 41. In describing these Figures, the same reference numerals for the same parts will be used as in Figures 4-6 for clarity and simplification.

Figure 37 is an enlarged side view, similar to the hydroplaning hydrofoil/airfoil structure 32 shown in Figures 4, 5, and 6 with fin 52 and struts 53-54 removed, showing an engine or electric motor 36 and air propeller 37 from Figure 1 mounted on stanchion 38 plus a topside air rudder 113 mounted along longitudinal top foil centerline 75 as shown in Figure 40 and elevator or aileron 114 attachment to air rudder 113. This buoyant hydroplaning hydrofoil/airfoil structure 32 is shown hydroplaning at water level 51 prior to flight and in Figure 38 the hydroplaning hydrofoil/airfoil structure 32 or flying wing, planes or flies through air in sustained flight.

Figure 39 is a front view and Figure 40 is a top view of the hydroplaning hydrofoil/airfoil structure 39 shown in Figures 37 and 38 hydroplaning at water level 51 and is similar to the structure shown in Figures 4-6 having the same reference numerals as shown in Figure 6 with fin 62 and struts 53-54 removed.

Figure 41 is a side view of the identical hydroplaning hydrofoil/airfoil structure 39 shown in Figures 4-6 gliding or planing through air. In this figure, fin 62 is retained.

As described for Figures 4-6, the hydroplaning hydrofoil/airfoil structure 39 in Figures 39 and 40 has a left side foil top surface 47 and a right side foil top surface 48 each having a fore foil top section (49 and 50 respectively) converging to form a full length fore and aft longitudinal top foil centerline 75, and a bottom centerline 76 formed by two converging full length foil planar-bottom surfaces, a left side foil planar-bottom surface 77 and a right side foil planar-bottom surface 78. Foil planar-bottom surfaces 77 and 78 ascend transversely from the longitudinal bottom centerline 76 to form a dihedral angle of about 18° as shown or in the range of about 2° to 50° broadly or preferably also in the range of about 2° to 50° or most preferably in the range of about 2° to 30°. Each left side foil planar-bottom surface 77 and right side foil planar-bottom surface 78 has a fore foil planar-bottom section (79 and 80 respectively) which is a forward extension along the longitudinal bottom centerline 75. Each fore foil planar-bottom section has a swept-back leading edge of 60° as shown or one preferably ranging from about 30° to about 80° swept-back as described for Figures 22 and 26 or most preferably ranging from about 45° to about 70° swept-back as described for Figures 27-29.

The length of each fore foil planar-bottom section 72 and 80, as shown in Figure 40 is the same as described for Figures 5 and 6, and is about the first one-third of the entire length or chord of the hydroplaning hydrofoil/airfoil structure along longitudinal top foil and bottom centerlines 75 and 76; however, the length of the fore foil planar-bottom sections in their broadest aspects can range from 0" shown in Figure 23 or in the preferred length of about one fourth of the chord length shown in Figure 26 to about the first two-thirds to three-fourths of the chord length along top foil and bottom centerlines 75 and 76 shown in Figures 22 and 25.

Each left side foil planar-bottom surface 71 and right side foil planar-bottom surface 78 has an aft foil planar-bottom section which is a backward or aft extension along the longitudinal bottom centerline 76. As shown in Figures 39 and 40, each aft foil planar-bottom section 68 and 69 at high speed water or fluid level 51 has a forward swept trailing edge 82 of 30° as shown or one preferably ranging from about 0° to about 60° forward swept as described for Figures 22 and 24-26 or most preferably from about 10° to about 45° forward swept as described for Figures 27-29.

The length of each aft foil planar-bottom section 68 and 69 is about the last one-fourth to about one-third of the entire chord length of the hydroplaning hydrofoil/airfoil structure along longitudinal bottom centerline 76 at high speed water or fluid level 51 as shown in Figure 39. The aft foil planar-bottom sections 68 and 69 vary in wetted surface area and length with speed and load; however, it is the section of the hydroplaning hydrofoil/airfoil structure which provides for high speed hydroplaning prior to sustained flight.

The left side and right side foil planar-bottom surfaces 77 and 78 have left wing and right wing forward swept leading edges 81 of 12° as shown in Figure 40; however, left and right leading edges 81 can be forward swept preferably in the range of about 0° to about 60° forward sweep as described for Figures 22 and 24-26, or most preferably in the range of about 4° to about 45° forward sweep as described for Figures 27-29. Foil planar-bottom surfaces 77 and 78 have forward swept trailing edges coextensive with aft foil planar-bottom section trailing edge 82, i.e., forward swept 30° as shown, but with forward swept ranges as described above.

The angle of attack may range from about 1° to 16° as described earlier for Figures 20-23 while accelerating through water level 51 before becoming airborne in sustained flight. Once airborne, the angle of attack varies greatly depending on speed, payload, and whether the airfoil structure 39 is ascending or descending. Motor 36, air propeller 37, stanchion 38, topside air rudder 113 and elevator 114 are as described in Figure 37.

Optional holes 89 shown in Figure 40 accommodate optional step 26 as described more fully for the description of Figure 10 and as shown in Figures 14A, 15, 16B and 17. These optional holes will also accommodate removable or permanent fin 62 as shown in Figures 5 and 41 or a rudder 72 as shown in Figures 7 and 8.

Optional power, wing stabilizers including winglets and canards, landing wheels, and passenger or payload carrying enclosures may be built in or attached to various scale hydroplaning hydrofoil or airfoil structures for gliding or propelled flight. In concluding the description of this invention, a light weight hydroplaning hydrofoil/airfoil structure selected

from Figures 4, 5, 6, and 17, enlarged but of identical foil shape, and merely having a weight added to the fore foil sections, performed repetitiously with a surprisingly long glide path, planing or gliding through air, supporting the inherent versatility of the disclosed structures of this invention to plane on or fly through a fluid preferably either water or air. This fore foil stabilized hydroplaning hydrofoil/airfoil structure in the spirit of flight is shown gliding in Figure 41.

In the claims which follow, reference to certain Figures of the drawings is for the purpose of ease of understanding and not by way of limitation.

WO 91/09767 PCT/US90/07359

1/10 2071527

FIG. 1

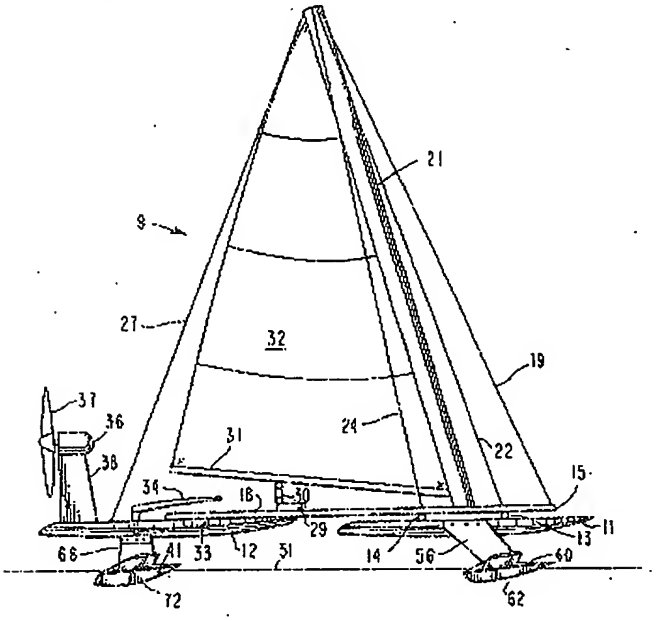


FIG. 2

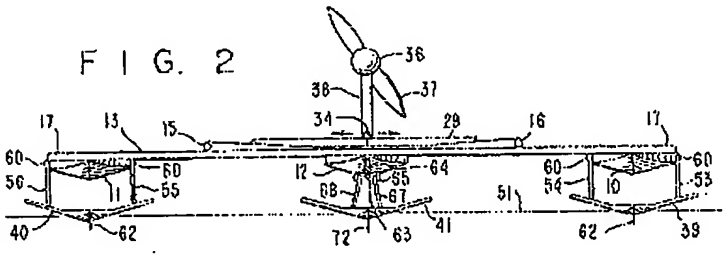
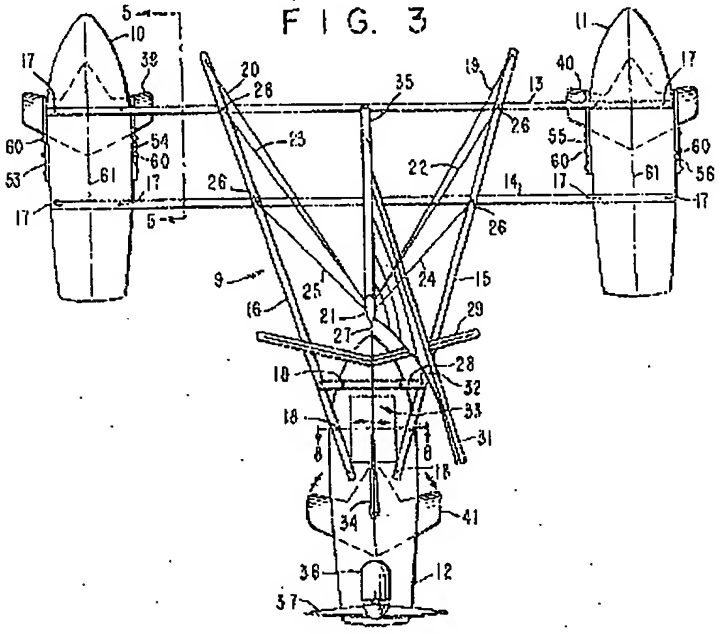

36
38
37
34
29
16
17
13
15
60
56
60
55
11
12
64
65
88
67
51
54
10
53
40
62
72
63
41
62
39

FIG. 3


5
10
38
17
20
28
35
19
13
40
11
26
55
60
54
60
53
61
17
22
14
56
9
25
24
15
16
21
29
27
28
32
33
18
31
8
18
34
41
36
12
37

WO 91/09767 PCT/US90/07355

2071527

FIG. 4

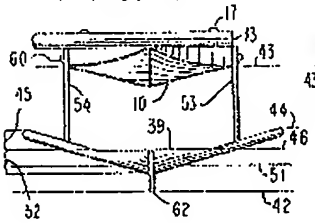


FIG. 5

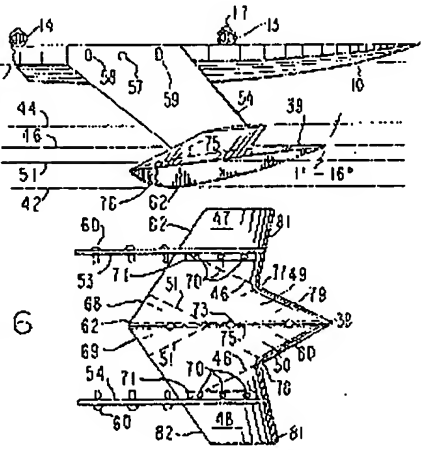


FIG. 6

FIG. 7

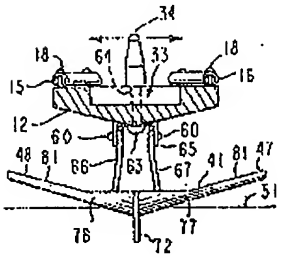


FIG. 8

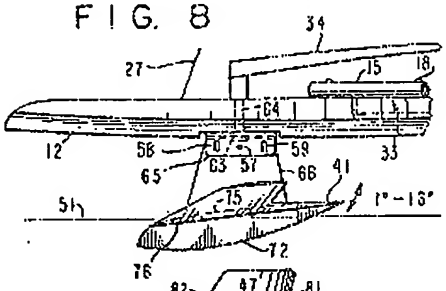
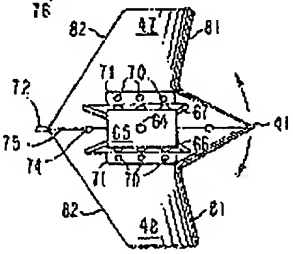


FIG. 9



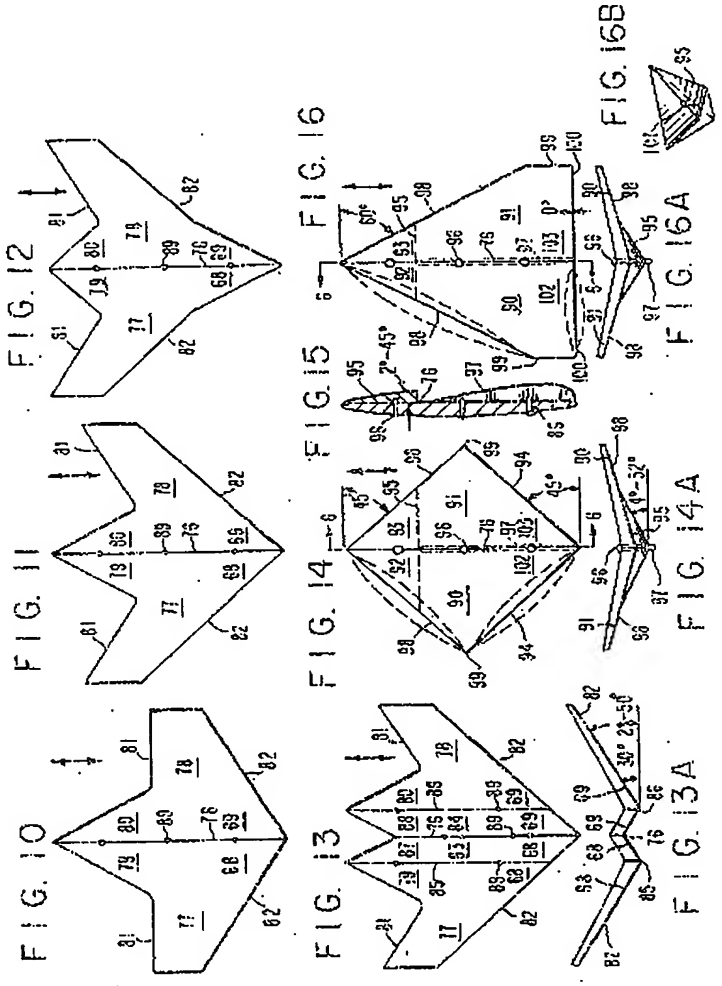


FIG. 12
FIG. 11
FIG. 10
FIG. 16
FIG. 15
FIG. 14
FIG. 13
FIG. 16B
FIG. 16A
FIG. 14A
FIG. 13A

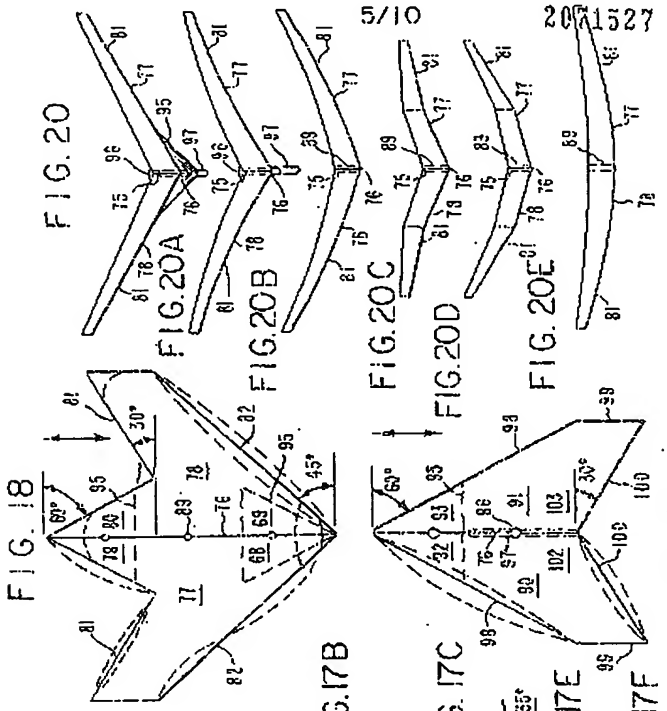


FIG. 20
FIG. 20A
FIG. 20B
FIG. 20C
FIG. 20D
FIG. 20E
FIG. 18
FIG. 19
FIG. 17
FIG. 17A
FIG. 17B
FIG. 17C
FIG. 17D
FIG. 17E
FIG. 17F

FIG. 21

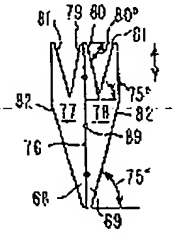


FIG. 22

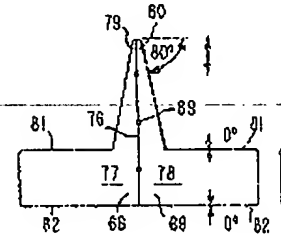


FIG. 23

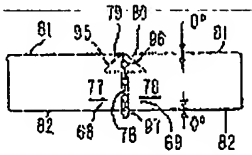


FIG. 24

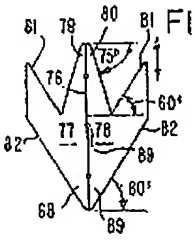


FIG. 25

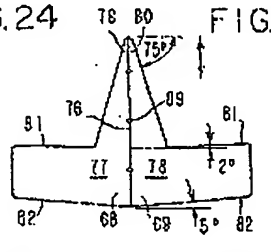


FIG. 26

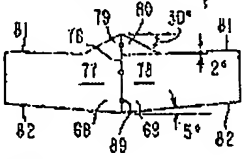


FIG. 27

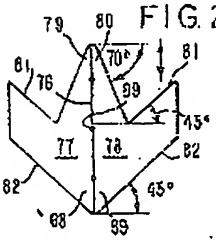


FIG. 28

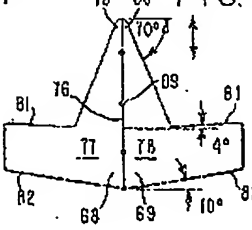
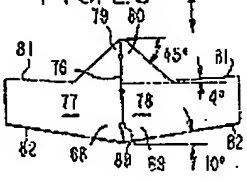


FIG. 29



WO 91/09767 PCT/US90/07355

2071527

7/10

FIG. 30

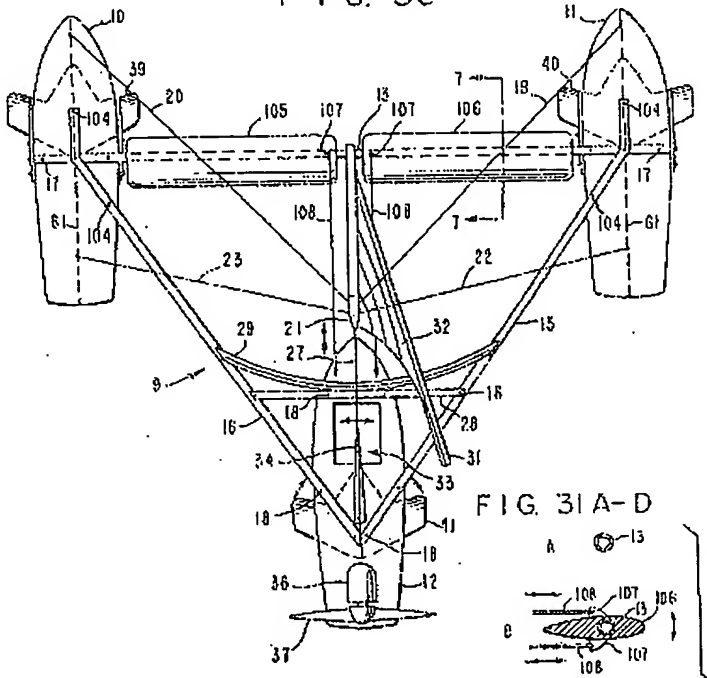


FIG. 31A-D

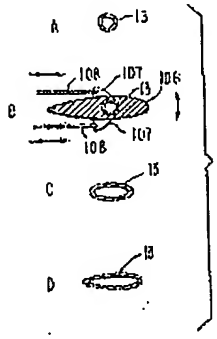


FIG. 30A

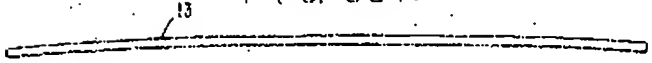


FIG. 32

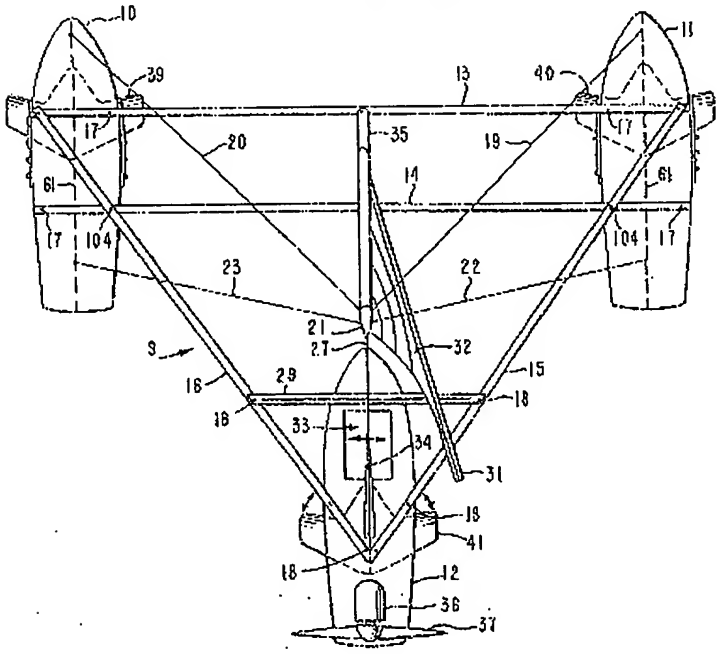

10
11
39
13
40
17
20
35
19
14
61
104
23
22
21
27
32
9
15
16
29
18
33
34
31
41
12
36
37

FIG. 34

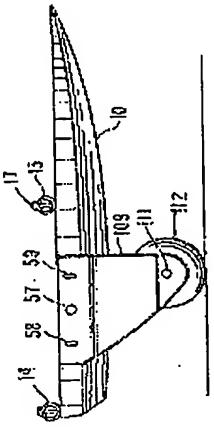


FIG. 36

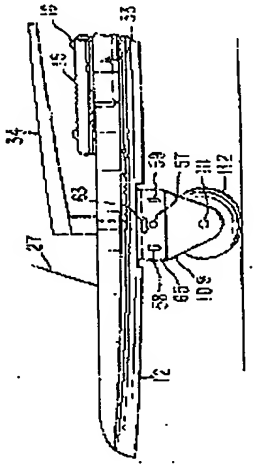


FIG. 33

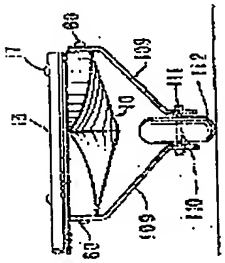


FIG. 35

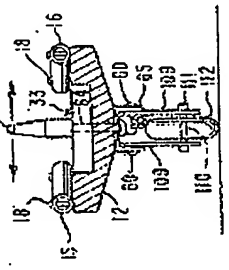


FIG. 37

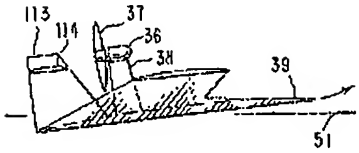


FIG. 38

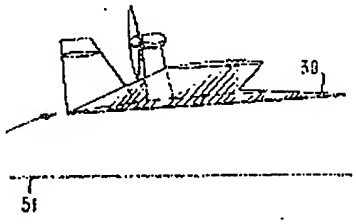


FIG. 39

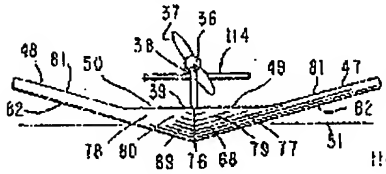


FIG. 40

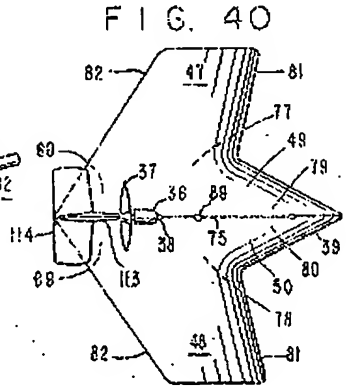


FIG. 41